PATENT APPLICATION
Atty Docket: 678-683 (P9823)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s):	HUH, Hoon et al.	**Examiner:** SHAH, Chirag G.
SERIAL NO.:	09/892,973	**Art Unit:** 2616
FILED:	June 27, 2001	

FOR: **METHOD AND APPARATUS FOR CONTROLLING PACKET TRANSMISSION IN A MOBILE TELECOMMUNICATION SYSTEM**

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

37 C.F.R. § 1.131 DECLARATION OF PRIOR INVENTION MADE IN THE REPUBLIC OF KOREA TO OVERCOME CITED PATENT

Sir:

We, Hoon HUH, Yu-Suk YUN, Soon-Young YOON, Jae-Heung YEOM, Sang-Hyun YANG and Hee-Won KANG, hereby declare that:

1. We are the inventors for the above-referenced patent application, which claims priority to application number 2000-35793 that was filed with the Korean Industrial Property Office on June 27, 2000.

2. This declaration is submitted to establish reduction to practice of the invention of the above-referenced patent application in the Republic of Korea prior to June 19, 2000, which is the effective filing date of U.S. Patent Application No. 6,708,040 B1, which was

issued to *Laroia*, and which was cited by the Examiner in the above-referenced patent application.

3. This declaration is submitted in response to the Office Action dated September 5, 2006.

4. To establish the date of reduction to practice of the invention of the above-referenced patent application, the following documents are attached hereto and are submitted as evidence:

    a. Exhibit A is an invention disclosure document;

    b. Exhibit B is a certified translation of Exhibit A; and

    c. Exhibit C is a certified translation of application number 2000-35793 that was filed with the Korean Industrial Property Office on June 27, 2000.

5. The invention disclosure document provided as Exhibit A hereto was completed at least before June 19, 2000, which is earlier than the effective filing date of *Laroia*.

6. The invention disclosure document and the translation thereof, provided as Exhibits A and B, respectively, to this Declaration show a reduction to practice of the invention claimed in the above-referenced patent application.

7. I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statement may jeopardize the validity of the application or any patent issuing thereon.

Date: Feb. 12, 2007

Hoon HUH

Country of Citizenship: Republic of Korea

Residence Post Office Address: 191-9, Seokbong-dong, Daedok-gu, Daejeon-Kwangyok-shi, Republic of Korea

Date: Feb. 12, 2007

Yu-Suk YUN

Country of Citizenship: Republic of Korea

Residence Post Office Address: 954-21, Daechi-dong, Kangnam-gu, Seoul, Republic of Korea

Date: Feb. 12, 2007

Soon-Young YOON

Country of Citizenship: Republic of Korea

Residence Post Office Address: 185, Gaepo-dong, Kangnam-gu, Seoul, Republic of Korea

Date: Feb. 12, 2007

Jae-Heung YEOM

Country of Citizenship: Republic of Korea

Residence Post Office Address: Dogok Jugong APT., #6-201, Daechi 1-dong, Kangnam-gu, Seoul, Republic of Korea

Date: Feb. 12, 2007

Sang-Hyun YANG

Country of Citizenship: Republic of Korea

Residence Post Office Address: 340-42, Haengdang 2-dong, Songdong-gu, Seoul, Republic of Korea

Date: Feb. 12, 2007

Hee-Won KANG

Country of Citizenship: Republic of Korea

Residence Post Office Address: Ahleum Samno APT. #401-1503, Imae-dong, Pundang-gu, Songnam-shi, Kyonggi-do, Republic of Korea

♦ Invention disclosure

<<Rights, which can be registered with respect to the present invention relating to the jobs of employees, are granted to an employees' corporation under the regulation of articles 39 and 40 of the patent law >>.

◙ The present employee invention is received to the intellectual property team of the telecommunication institute (Suwon city and Gumi city).

◙ Title of Invention : METHOD FOR IMPROVING THROUGHPUT AND POWER EFFICIENCY OF LINK ADAPTATION SCHEME AND ARQ SCHENE IN MOBILE COMMUNACATION SYSTEM

◙ Name of Subject:subject commercializing cdma2000 ◙ Subject Code:DN901 ◙ Name of Product:

◙ Name of Core Technique (Code)

◙ Evaluation of technical contents

Items						
Type of Invention	•individual invention ○ industry-university cooperation ○ outside development ○ corporative development					
Contract Management	[Contract Attachment] The name of File / The description of File [inscription of a property right and description about compensation problems]					
Disclosed Particulars	Due date of disclosure		Disclosed country and organization		Disclosure type	

◙ Identification of inventors

Inventor's name	Assigned Department / Inventor's Resident Number	Representative	Share (%)	Inventor's address
HOON HUH	cdma2000system develop. Team / 740817-148823	○	25	333-608, hanyang APT, seohyeon dong, bundang gu, sungnam si, Kyeonggi do
HEE-WON KANG	cdma2000system develop. Team / 680119-1051636	-	15	216-413, Hanshin6th APT, banpo dong, seocho gu, Seoul
SANG-HYUN	cdma2000system develop. Team	-	15	208-503, hyangchonhyundai4th APT, pyeongchon dong, dongan gu, anyang si,

	720614-1836218			
JAE-HEUNG YEOM	cdma2000system develop. Team 690704-1074418	-	15	B2 677-11, ilweon1 dong, kangnam gu, Seoul
SOON-YOUNG YOON	cdma2000system develop. Team 660112-1552723	-	15	9-106, asiaseonsuchon APT, chamshil7 dong, songpa gu, Seoul
YU-SUK YUN	cdma2000system develop. Team 711019-1462135	-	15	111-103, samgsung APT, daechi1 dong, kangnam gu, Seoul

■ File of employee invention report

Name of File	Description of File
LinkAdapt.hwp	Invention Specification
InventionDeclaration 1.gul	Invention Declaration

■ Judgment of invention grade

Subjects of Judgment		Date of Judgment	Grade	Opinion
Inventor	HOON HUH	May19,2000	A	technology connected with research & development, and an applicable technology which is most likely to realize
Chief of inventor	JOONG-HO JUNG	May19,2000	A	technology related to High Data Rate (HDR), and scheduled to be standarized
Patent Team		May24,2000	B	a package input through computers
Evaluation committee		Sep.1st,2000	A	a package input through computers

■ Dates regarding employee invention

Date of Inventor Report	May 19,2000	Approval Date of Team Leader	May19,2000	Receipt Date of Patent Team	May22,2000

■ Receipt number of employee invention : GC-200005-079-1

<table>
<tr><td colspan="3">Employee Invention Report (Invention Disclosure)
● Title of Invention
* Simple & clear title capable of expressing the content of the invention</td><td colspan="5" rowspan="2">[Points to be pre-checked]
○ prompt application is necessary under the first-to-file system
○ complete invention is necessary
- the invention must be backed up by embodiments, data, etc.
- incomplete or only desired idea is not available
○ publication before application is prohibited
- academy presentation, paper publication, sale, display, etc. are prohibited</td></tr>
<tr><td>Korean</td><td colspan="2">METHOD FOR IMPROVING THROUGHPUT AND POWER EFFICIENCY OF LINK ADAPTATION SCHEME AND ARQ SCHEME IN MOBILE COMMUNICATION SYSTWM</td></tr>
<tr><td>English</td><td colspan="2">METHOD FOR IMPROVING THROUGHPUT AND POWER EFFICIENCY OF LINK ADAPTATION SCHEME AND ARQ SCHEME IN MOBILE COMMUNICATION SYSTWM</td><td colspan="5"></td></tr>
<tr><td colspan="3"></td><td colspan="5">- all technologies in relation to the present invention, which have already been filed or are currently pending
- improvement application can be filed within one year from the first application data, with domestic priority claiming</td></tr>
<tr><td rowspan="6">[Technology Source] (optionally fill only correspondin g blanks)</td><td rowspan="3">Similar patent or application</td><td colspan="2">Application/registration No.</td><td></td><td>Application/registration Date</td><td></td></tr>
<tr><td colspan="2">Title of Invention</td><td colspan="3"></td></tr>
<tr><td colspan="2">Applicant</td><td colspan="3"></td></tr>
<tr><td rowspan="2">Background document or product</td><td>Document name/product model name</td><td></td><td>Publisher/manufacturer</td><td></td></tr>
<tr><td>Publication/production date</td><td></td><td>Page/others</td><td></td></tr>
<tr><td rowspan="2">Prior application(s) of the inventor(s) related to the invention</td><td rowspan="2">Filed application(s)</td><td>Title of invention</td><td colspan="3"></td></tr>
<tr><td>Application no./date</td><td colspan="3">(19 . . .)</td></tr>
<tr><td></td><td rowspan="2">Pending application(s)</td><td>Title of invention</td><td colspan="3"></td></tr>
<tr><td></td><td>Receipt no./date</td><td colspan="3">(19 . . .)</td></tr>
</table>

[Abstract]

Disclosed is a scheme for adapting a mobile communication system to a state of a channel thereof. In a repeated transmission of a packet in a link adaptation scheme, and in the retransmission of a packet in each of an Automatic Repeat reQuest (ARQ) scheme and a hybrid ARQ scheme, whether to perform a decoding and a Cyclic Redundancy Check (CRC) is determined by using a received Carrier to Interference ratio (C/I) of a pilot channel or of a pilot symbol. Through feedback of an ACKnowledgement (ACK), a Negative ACKnowledgement (NACK), and a signal for requesting the retransmission according to a result of the CRC, the increase of a throughput of a channel, the reduction of power consumption, and the decrease of a required storage capacity of a storage device of a transmitter due to a reduction of feedback delay time, can be accomplished. In a case when a value of the received C/I of the pilot is greater than an upper threshold which, following the decoding, guarantees packet error probability below a prescribed value, the decoding is performed, and then the CRC is checked. If there is no error as a result of the CRC, the ACK is sent to the transmitter, and the repeated transmission or the retransmission is stopped. Otherwise, repeated transmission or retransmission is requested. Further, in a case where even though this value of the pilot C/I or the accumulated value is combined after the retransmission is performed by the maximum number of times of the repeated transmission, this value of the pilot C/I or the accumulated value is less than a lower threshold for which it is certain that the error is most likely to exist, the NACK is sent to the transmitter to give up the transmission from the beginning, or the retransmission and the repeated transmission are given up, and then the packet is transmitted again from the beginning. In a case when the value of the pilot C/I corresponds to the mean of the upper and lower thresholds, the repeated transmission or retransmission is requested.

[ABSTRACT OF THE DISCLOSURE]

[Abstract]

Disclosed is a scheme for adapting a mobile communication system to a state of a channel thereof. In a repeated transmission of a packet in a link adaptation scheme, and in the retransmission of a packet in each of an Automatic Repeat reQuest (ARQ) scheme and a hybrid ARQ scheme, whether to perform a decoding and a Cyclic Redundancy Check (CRC) is determined by using a received Carrier to Interference ratio (C/I) of a pilot channel or of a pilot symbol. Through feedback of an ACKnowledgement (ACK), a Negative ACKnowledgement (NACK), and a signal for requesting the retransmission according to a result of the CRC, the increase of a throughput of a channel, the reduction of power consumption, and the decrease of a required storage capacity of a storage device of a transmitter due to a reduction of feedback delay time, can be accomplished. In a case when a value of the received C/I of the pilot is greater than an upper threshold which, following the decoding, guarantees packet error probability below a prescribed value, the decoding is performed, and then the CRC is checked. If there is no error as a result of the CRC, the ACK is sent to the transmitter, and the repeated transmission or the retransmission is stopped. Otherwise, repeated transmission or retransmission is requested. Further, in a case where even though this value of the pilot C/I or the accumulated value is combined after the retransmission is performed by the maximum number of times of the repeated transmission, this value of the pilot C/I or the accumulated value is less than a lower threshold for which it is certain that the error is most likely to exist, the NACK is sent to the transmitter to give up the transmission from the beginning, or the retransmission and the repeated transmission are given up, and then the packet is transmitted again from the beginning. In a case when the value of the pilot C/I corresponds to the mean of the upper and lower thresholds, the repeated transmission or retransmission is requested.

[Representative figure]

FIGS. 6 and 7

[SPECIFICATION]

[TITLE OF THE INVENTION]

METHOD FOR IMPROVING THROUGHPUT AND POWER EFFICIENCY OF LINK ADAPTATION SCHEME AND ARQ SCHEME IN MOBILE COMMNICATION SYSTEM

[BRIEF DESCRIPTION OF DRAWINGS]

FIG. 1 is a conceptual view illustrating slot transmission-reception timing of an HDR downlink and an HDR reverse-link or uplink according to a preferred embodiment of the present invention;

Fig. 2 is a flow chart illustrating an algorithm in which an AT requests a data transfer rate from an AN according to a preferred embodiment of the present invention;

FIG. 3 is a conceptual view illustrating the length of a packet according to a downlink data transfer rate of the HDR according to a preferred embodiment of the present invention;

FIG. 4 is a flowchart illustrating an algorithm which requests the retransmission during the occurrence of an error in the hybrid ARQ scheme according to a preferred embodiment of the present invention;

FIG. 5 is a conceptual view illustrating slot transmission-reception timing of a downlink and an uplink of HDR according to a first embodiment of the present invention;

FIG. 6 is a flowchart illustrating an algorithm in which an AT requests a data transfer rate from an AN, or the AT transmits an ACK or a Negative ACKnowledgement (NACK) to the AN in a HDR system according to a first embodiment of the present invention; and

FIG. 7 is a flowchart illustrating an algorithm in which an ACK or a

NACK is transmitted in a hybrid ARQ scheme of a 1Xtreme system according to a second embodiment of the present invention.

[DETAILED DESCRIPTION OF THE INVENTION]

[OBJECT OF THE INVENTION]

[FIELD OF THE INVENTION AND PRIOR ART IN THE FIELD]

The present invention relates to a scheme for adapting a mobile communication system to a state of a channel thereof, and more particularly to a method for improving throughputs and power efficiencies of a link adaptation scheme, an Automatic Repeat reQuest (ARQ) scheme and a hybrid ARQ scheme in a mobile communication system.

In mobile communication, according to the distance and shadow, the attenuation of a propagation path changes, and interference and fading among systems are intense as well, so that variation of a Carrier to Interference ratio (hereinafter, referred to as "C/I") according to a state of a channel (hereinafter, referred to as "channel state") is considerable. A link adaptation scheme controls the amount of data according to the channel state, to increase throughput of the channel. The link adaptation scheme adaptively selects a coding rate and a modulation scheme, so that a data transfer rate is increased in a good channel state, whereas a data transfer rate is decreased in a bad channel state. The data transfer rate is determined according to the coding rate and the modulation scheme, both of which enable users to communicate in a prescribed reliability according to the channel state. When a received C/I is high, the data transfer rate is increased by using a code of a high coding rate and by using a high level of the modulation scheme. On the contrary, when a received C/I is low, the data transfer rate is decreased by using a code of a low coding rate and by using a low level of the modulation scheme, where reliability of the channel is raised instead. A receiver feeds back to a transmitter the data transfer rate determined by predicting variation of the following channel on the basis of the received C/I, or feeds a value of the received C/I itself back to the transmitter. In a case of the

latter, a base station determines the data transfer rate. The link adaptation scheme is also called "an adaptive coding and modulation scheme."

On the other hand, there is an Automatic Repeat reQuest (ARQ) scheme for checking a Cyclic Redundancy Check (CRC) of a received packet, and for requesting a transmitter to retransmit the packet when the CRC is checked with an error. In the ARQ scheme, because the retransmission is requested in a case of a bad channel state so that the transmitter may retransmit the packet repeatedly, an actual data transfer rate is reduced, and reliability of a channel is raised as well. Namely, the ARQ scheme allows for adapting itself to the channel. There is another scheme called "a hybrid ARQ scheme." In the hybrid ARQ scheme, by using the CRC together with an Error Correcting Code (ECC), a coding rate is reduced during the retransmission and retransmitted packets are combined and then demodulated.

In the above link adaptation scheme, the coding rate and the modulation scheme are determined according to the C/I of a received signal. It is usual that most of received C/Is of traffic channels use received C/Is of pilot symbols or pilot channels. When the received C/I is low, a low coding rate and a low level of a modulation scheme are selected, and simultaneously, in order to increase a bit energy-to-noise ratio, the same packet is repeatedly transmitted. Then, repeated packets are also combined on the receiving side. For example, in a High Data Rate (HDR) air interface specification of Qualcomm Inc., a packet is going to be repeatedly transmitted sixteen times in 38.4 [kbps]. As repeated transmissions like this cause transmission of the packet to take a long time, a prediction error of the channel becomes larger. For this, the coding rate and the modulation scheme cannot quickly change with variation of the channel. As it takes a long time to transmit the packet at a low data transfer rate, resources are also occupied for a long time, which causes throughputs of the channels to be reduced as a whole.

Next, the prior arts will be described with an example of a mobile communication system based on forward-link or downlink of the HDR specification suggested in 3rd Generation Partnership Project 2 (3rd GPP2), in

order to supplement data communications of IS-2000. The above-mentioned transmitter becomes an Access Network (AN), and the receiver becomes an Access Terminal (AT). In a physical layer of HDR according to the link adaptation scheme, there are thirteen types of transmission schemes with a combination among three modulation schemes including Quadrature Phase Shift Keying (QPSK), 8-ary Phase Shift Keying (8PSK) and 16-ary Phase Shift Keying (16 Quadrature Amplitude Modulation: 16QAM), three coding rates including 1/4, 3/8 and 1/2, and the number of slots by which the packet is repeated. FIG. 1 is a conceptual view illustrating slot transmission-reception timing of an HDR downlink and an HDR reverse-link or uplink. The structure of a transmission packet includes 2048 chips per slot, and the modulation scheme uses QPSK, 8PSK, and 16QAM, etc., according to a data transfer rate. As illustrated in FIG. 1, in the manner where one chip is assigned to half a slot, 96 chips are assigned to each of two pilot channels. Because a pilot symbol is always transmitted with the same electric power as that of a traffic channel, a C/I of the traffic channel can be estimated by using a C/I of the pilot channel.

Fig. 2 is a flow chart illustrating an algorithm in which an Access Terminal (AT) requests a data transfer rate from an Access Network (AN). The AT searches each and every slot for a preamble, and ascertains if the preamble corresponds to information provided to the AT. If the AT ascertains that a packet is provided to the AT, the AT checks the length of the preamble to ascertain if the data transfer rate corresponds to a data transfer rate requested by the AT. If the data transfer rate corresponds to the requested data transfer rate, by using a value of a C/I estimated for a pilot channel in the packet, the AT determines a data rate at which the AT can receive the packet, and then transmits and feeds the determined data rate back to a transmitter. At this time, a channel through which the determined data rate is transmitted and fed back to the transmitter, is called "a Data Rate Control (DRC) channel." FIG. 3 is a conceptual view illustrating the length of a packet according to a downlink data transfer rate of the HDR. One packet is going to be repeatedly transmitted for a time period of 16 slots at a data

transfer rate of 38.4 [kbps], and is going to be repeatedly transmitted for a time period of 8 slots at a data transfer rate of 76.8 [kbps]. On the other hand, both 1843.2 [kbps] using a code of 1/2 and 8PSK, and 2457.6 [kbps] using a code of 1/2 and 16QAM are transmitted at intervals of one slot. Hence, in a case of a low data transfer rate, the length of the packet is so long that a transmission scheme cannot quickly change with variation of the channel, which causes a waste of wireless resources. What's more, since a Time Division Multiplexing Access (TDMA) scheme is used among users in the downlink of the HDR, in a case when the users, who make use of a low data transfer rate, occupy plenty of slots, it is problematic that the overall throughput becomes very low.

Next, the prior arts will be described with examples of the ARQ scheme and the hybrid ARQ scheme of 1Xtreme standards suggested in 3rd GPP2 in order to supplement data communications of IS-2000. FIG. 4 is a flowchart illustrating an algorithm which requests the retransmission during the occurrence of an error in the hybrid ARQ scheme. If a receiver receives a packet, the receiver ascertains if there exists the same packet which has been previously received. If so, the receiver combines the currently received packet with the same packet previously received. Then, the receiver decodes a combined signal, and checks a CRC. If the CRC is checked without an error, the receiver sends an ACKnowledgement (ACK) to a transmitter. If the CRC is checked with the error, the receiver request the retransmission of the packet. The ARQ and the hybrid ARQ are the schemes that decode the received packet to check the CRC in order to determine whether to retransmit the packet. In a case where a channel state is very bad, an error is most likely to be continuously detected in the process of the CRC check following the demodulation. On this, the retransmission is continually requested. In this process, a repeated decoding unnecessarily consumes an enormous amount of power. Feedback delay time increases by the amount of time required for the decoding. If a continuous retransmission is requested and feedback time is delayed as well, the transmitter has to continually store a large number of packets, and therefore needs a mass storage device. Even

though both the ARQ and the hybrid ARQ are the schemes capable of automatically adapting to the channel state, because the decoding processes are performed whenever the packets are received even when there is a strong likelihood of the errors in the packets, power consumption and delays are caused by the decodings, and storage capacity of the storage devices required in case the channel states are very bad, becomes large.

In conclusion, the schemes for adapting transmission methods and the number of times of the transmission to the channel states to increase throughputs include the link adaptation scheme, the ARQ scheme, and the hybrid AQR scheme, etc. When the channel states are not good, the link adaptation scheme has demerits causing decrease of the throughput, and both the ARQ and the hybrid ARQ schemes have demerits that cause a waste of power, an increase in delay time, and the requests for the storage devices by repeating the decodings with continuous requests for the retransmissions.

[TECHNICAL OBJECTS TO BE ACHIEVED BY THE INVENTION]

Accordingly, the present invention has been made to solve the above problems occurring in the prior art, and it is an object of the present invention to provide a method for improving throughputs by increasing speed for adaptation to channels in a link adaptation scheme, an Automatic Repeat request (ARQ) scheme, and a hybrid ARQ scheme used in a mobile communication system.

Furthermore, it is another object of the present invention to provide a method for determining whether to decode received packets before checking Cyclic Redundancy Checks (CRCs) following decodings, for being able to require the retransmissions of or stopping the retransmissions of the packets, and for reducing power consumption, delays of feedback time, and storage capacity of storage devices in the link adaptation scheme, the ARQ scheme, and the hybrid ARQ scheme.

In order to accomplish the above objects of the present invention, there is provided a method in which in a repeated transmission of a packet in a link

adaptation scheme, and in the retransmission of a packet in each of an Automatic Repeat reQuest (ARQ) scheme and a hybrid ARQ scheme, a Carrier to Interference ratio (C/I) of a pilot channel or of a pilot symbol is estimated, and then decoding is performed if the estimated C/I is greater than an upper threshold which following the decoding, guarantees packet error probability below a prescribed value. If not, retransmission or repeated transmission is requested. Moreover, if the estimated C/I is greater than a lower threshold for which it is certain that the error is most likely to exist following the decoding, the transmission is given up from the beginning, or the retransmission and the repeated transmission are given up, and then the packet is transmitted again from the beginning.

[CONSTRUCTION AND FUNCTION OF THE INVENTION]

Hereinafter, preferred embodiments of the present invention will be described with reference to the accompanying drawings.

A first embodiment of the present invention is as follows. FIG. 5 is a view containing a basic structure of the present invention, and illustrates slot transmission-reception timing of a downlink and an uplink of a HDR system applied to the present invention. When a transmitter has finished transmitting a packet, after a receiver receives the packet to decode the received packet, the receiver checks a CRC related to the received packet, and feeds back to the transmitter an ACK, a NACK, etc., aside from Data Rate Control (DRC), corresponding to the result of the CRC. The significance of the ACK or the NACK may be different from the meaning in a usual ARQ. The ACK of the present invention is a signal required to stop a repeated transmission or the retransmission at the time of ascertaining that there exists no error after a decoding of the received signal. The NACK is a signal required to stop a repeated transmission or the retransmission because it is certain that the error is most likely to continually exist even though the received signal is retransmitted or repeatedly transmitted.

However, the decoding and the CRC related to the received packet are not performed each time, but generally, whether to perform the decoding and to check the CRC is determined by estimating a C/I of a pilot symbol transmitted in time division in the packet or a C/I of a pilot channel transmitted through a separate channel. In a case when a value of the received C/I of the pilot is greater than an upper threshold which, following the decoding, guarantees packet error probability below a prescribed value, the decoding is performed, and then the CRC is checked. In a case where the packet is repeatedly transmitted or retransmitted, a value to which the pilot C/I of each packet has accumulated is used. If there is no error as a result of the CRC, the ACK is sent to the transmitter, and the repeated transmission or the retransmission is stopped in response. Otherwise, the repeated transmission or the retransmission is requested. Further, in a case where even though this value of the pilot C/I or the accumulated value is combined after the retransmission is performed by the maximum number of times of the repeated transmission, this value of the pilot C/I or the accumulated value is less than a lower threshold for which it is certain that the error is most likely to exist, the NACK is sent to the transmitter to give up the transmission from the beginning, or the retransmission and the repeated transmission are given up, and then the packet is transmitted again from the beginning. In a case when the value of the pilot C/I corresponds to the mean of the upper and lower thresholds, the repeated transmission or retransmission is requested.

FIG. 6 is a flowchart illustrating an algorithm in which an AT requests a data transfer rate from an AN by using a DRC, an ACK, and a NACK, or stopping a repeated transmission is requested in a HDR system according to a first embodiment of the present invention. In a case where the AN receives the ACK or the NACK from the AT, the AN stops a current transmission of the packet. Otherwise, the AN continues to transmit the packet at a data transfer rate that the AT requests. The AT searches each and every slot for a preamble, and ascertains if the preamble corresponds to the packet provided to the AT. If the AT ascertains that the packet is provided to the AT, the AT checks the length of the

preamble to ascertain if the packet corresponds to a low data transfer rate of data repeatedly transmitted for a time period of 2 slots or over. In a case of a high data transfer rate at which there is no repeated transmission, the AT estimates the pilot C/I to transmit only the DRC to the AN. In a case of the low data transfer rate, the AT estimates the pilot C/I, and then the estimated pilot C/I and a previously repeated value of the C/I accumulate to a value if there exists the previously repeated value of the C/I. Then, the accumulated value of the pilot C/I is compared with the upper and lower thresholds. In a case where the accumulated value of the pilot C/I is greater than the upper threshold, the decoding is performed, and then the CRC is checked. In a case when there is no error following the CRC, the AT transmits the ACK to the AN to stop the repeated transmission. In a case of the existence of an error, the AT transmits the DRC to the AN to continually perform the repeated transmission. If an estimation of the C/I is accurate, the AT omits the decoding and the process of the CRC, and can transmits the ACK at once. On the other hand, in a case where the accumulated value of the pilot C/I is less than another lower threshold when the accumulated value of the pilot C/I is compared with another lower threshold, the AT gives up the decoding, and then transmits the NACK to the AN to stop the repeated transmission. The lower threshold is a value for which it is certain that the error is most likely to exist, even though the value of the pilot C/I or the accumulated value is combined after the repeated transmission is performed by a length of the packet. The lower threshold has a value which is different from one another according to the number of times of the repeated transmission. TABLE 1 is an example of correspondence relations among 4-bit DRC symbols, data transfer rates, an ACK, and a NACK.

TABLE 1

4-bit DRC symbols	data transfer rates and ACK/NACK
0000	38.4 kbps

0001	76.8 kbps
0010	102.4 kbps
0011	153.6 kbps (short)
0100	153.6 kbps (long)
0101	204.8 kbps
0110	307.2 kbps (short)
0111	307.2 kbps (long)
1000	614.4 kbps
1001	921.6 kbps
1010	1228.8 kbps
1011	1843.2 kbps
1100	2457.6 kbps
1101	ACK
1110	
1111	NACK

In TABLE 1, "short" and "long" respectively denote a short packet and a long packet, and 1101 and 1111, which are left over among 16 DRC symbols correspond to the ACK and the NACK.

A second embodiment of the present invention is as in the following. FIG. 7 is a flowchart illustrating an algorithm of an operation using an ACK and a NACK in a hybrid ARQ scheme of a 1Xtreme system. When a packet is received from an AN by an AT, the AT estimates a C/I of a pilot channel, and the estimated C/I of the pilot channel is accumulated to a previously accumulated pilot C/I, if there exists the previously accumulated pilot C/I. Also in a symbol of a traffic channel, if there exists the same packet which has been previously transmitted, a symbol of a current packet is combined with a symbol of the same packet which has been previously transmitted. Only if a C/I value of an accumulated pilot is greater than an upper threshold, are decoding and a CRC performed for the

combined traffic symbols. If it is ascertained that there is no error of the packet as a result of the CRC, the AT transmits and feeds the ACK back to the AN to end the retransmission. If the CRC is checked with the error of the packet, the AT requests the retransmission from the AN. The packet without the error is passed to a higher layer, and decoded data and the accumulated pilot C/I are deleted. On the other hand, if the accumulated C/I is less than the upper threshold, the accumulated C/I is compared with the lower threshold. If the accumulated C/I is greater than the lower threshold, the AT requests the retransmission of the packet. If not, the AT transmits the NACK to give up the retransmission, and then the packet is transmitted again from the beginning or resources are assigned to other users. The lower threshold is a value for which it is certain that the error is most likely to exist, even though the value of the pilot C/I or the accumulated value is combined after the retransmission is performed by the maximum number of times of the retransmission. The lower threshold has a value which is different from one another according to the number of times of the retransmission.

Because other than the usual ARQ or hybrid ARQ scheme, the unnecessary processes of the decoding and of the CRC can be eliminated in advance by comparing the value of the C/I before the decoding, the increase of power consumption, feedback delay time, and a requisite for storage capacity of a storage device of a transmitter can be reduced.

[Effect of the Invention]

As described above, in the present invention, at the time of a request of a repeated transmission of a link adaptation scheme, or of the retransmission of an ARQ or hybrid ARQ scheme, by performing a decoding and then checking an CRC when packet error probability can be maintained to a prescribed level by using a result of estimating a C/I, the increase of a throughput of a channel, the reduction of power consumption, and the decrease of a required storage capacity of a storage device of a transmitter, etc., can be accomplished.

[Claims]

[Claim 1]

A mobile communication system using a link adaptation scheme, the mobile communication system comprising:

a scheme for transferring to a transmitter whether it is required to continually and repeatedly transmit a packet through a decoding and a Cyclic Redundancy Check (CRC) every time the packet is transmitted at a low data transfer rate at which the packet is repeatedly transmitted; and

a structure of a receiver for performing a decoding and the CRC only when packet error probability is equal to or less than a prescribed value through estimating a received Carrier to Interference ratio (C/I) of a pilot prior to the decoding without need of the decoding each time.

[Claim 2]

The mobile communication system as claimed in claim 1, wherein the receiver comprises a scheme for and a structure thereof for transferring to the transmitter that there is no need to continually and repeatedly transmit the packet in a case where an error of the packet is certainly predicted through estimating the received C/I of the pilot prior to the decoding each time.

[Claim 3]

A mobile communication system using an Automatic Repeat reQuest (ARQ) scheme or a hybrid ARQ scheme, the mobile communication system comprising:

a scheme for and a structure of a receiver for performing a decoding and a Cyclic Redundancy Check (CRC) only when packet error probability is equal to or less than a prescribed value through estimating a received Carrier to Interference ratio (C/I) of a pilot prior to the decoding with regard to a packet which is first transmitted or is repeatedly transmitted.

[Claim 4]

The mobile communication system as claimed in claim 3, wherein the

receiver comprises a scheme for and a structure thereof for transferring to a transmitter that there is no need to continually and repeatedly transmit the packet in a case where an error of the packet is certainly predicted through estimating the C/I prior to the decoding as to a packet which is first transmitted or is repeatedly transmitted.

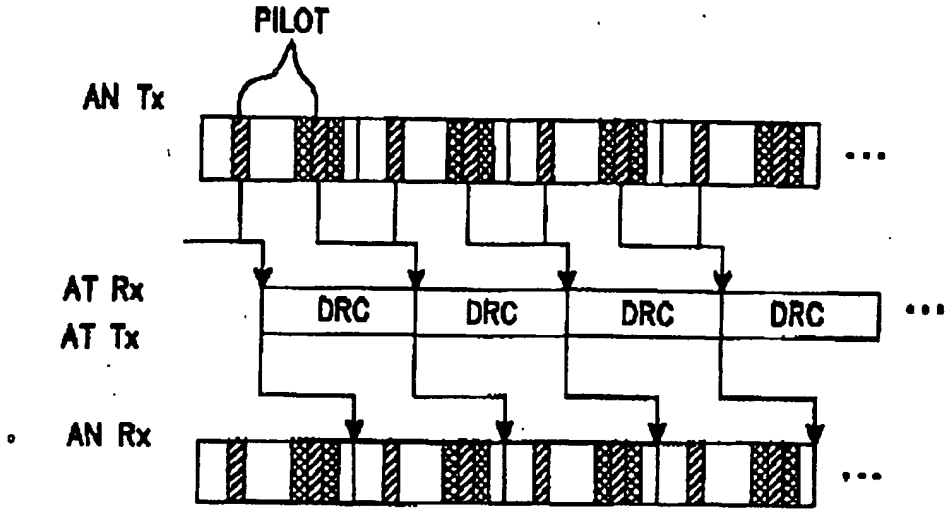


FIG. 1

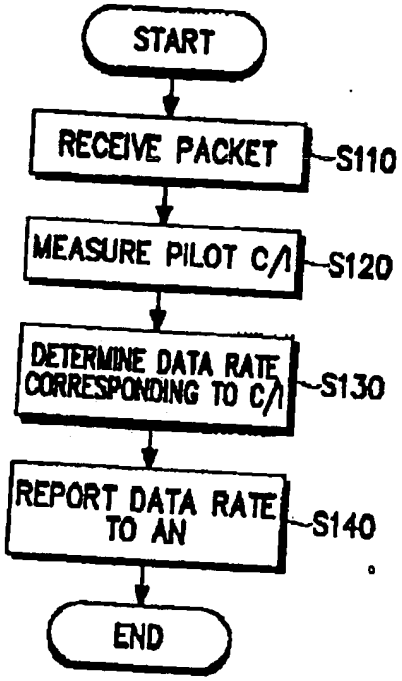

START
RECEIVE PACKET
S110
MEASURE PILOT C/I
S120
DETERMINE DATA RATE CORRESPONDING TO C/I
S130
REPORT DATA RATE TO AN
S140
END

FIG. 2

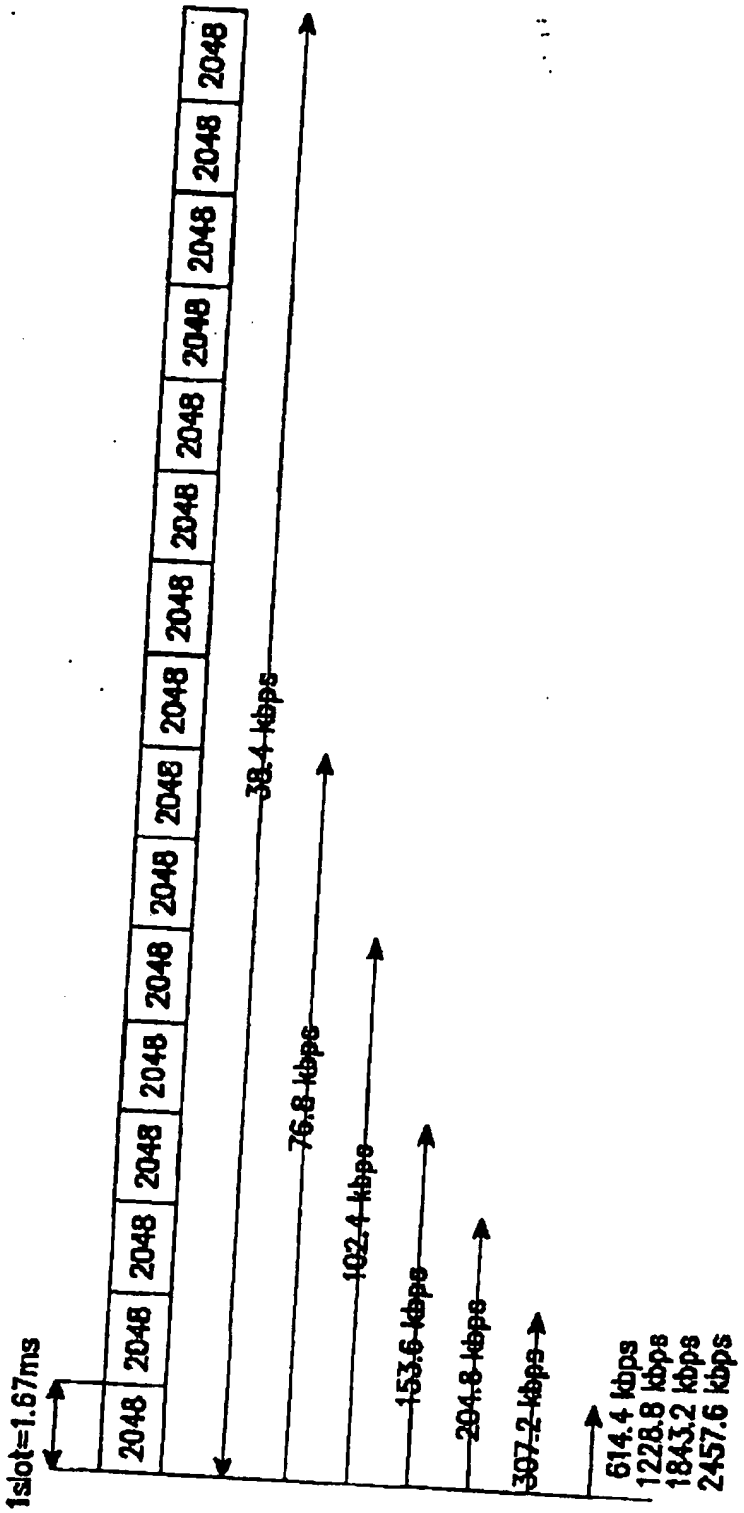

1slot=1.67ms
2048
38.4 kbps
76.8 kbps
102.4 kbps
153.6 kbps
204.8 kbps
307.2 kbps
614.4 kbps
1228.8 kbps
1843.2 kbps
2457.6 kbps

FIG. 3

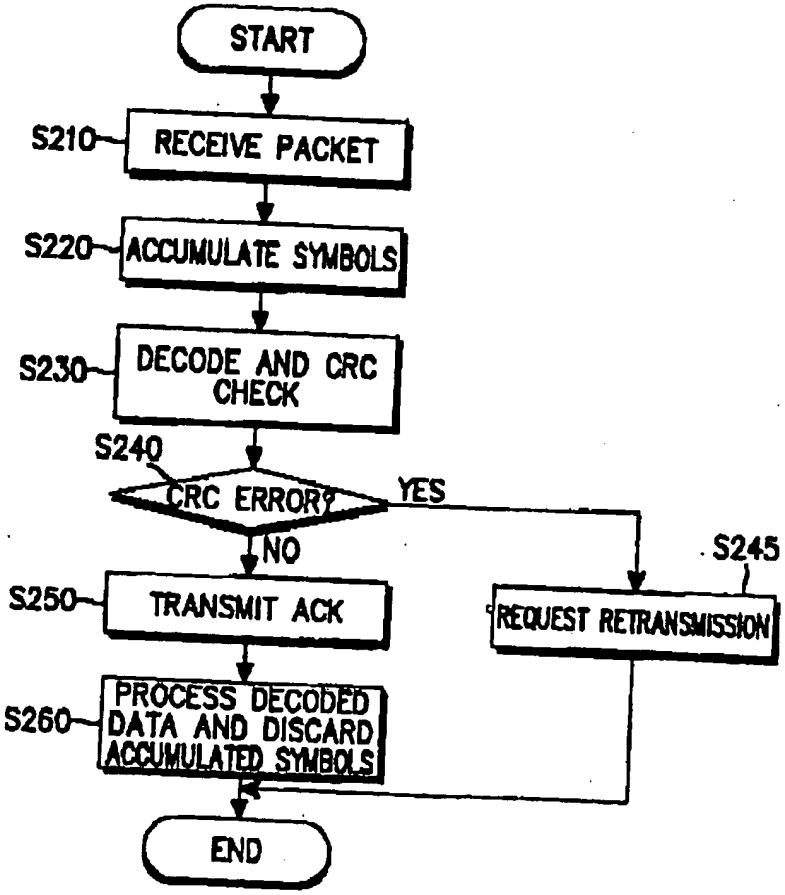

START
S210
RECEIVE PACKET
S220
ACCUMULATE SYMBOLS
S230
DECODE AND CRC CHECK
S240
CRC ERROR?
YES
NO
S245
REQUEST RETRANSMISSION
S250
TRANSMIT ACK
S260
PROCESS DECODED DATA AND DISCARD ACCUMULATED SYMBOLS
END

FIG. 4

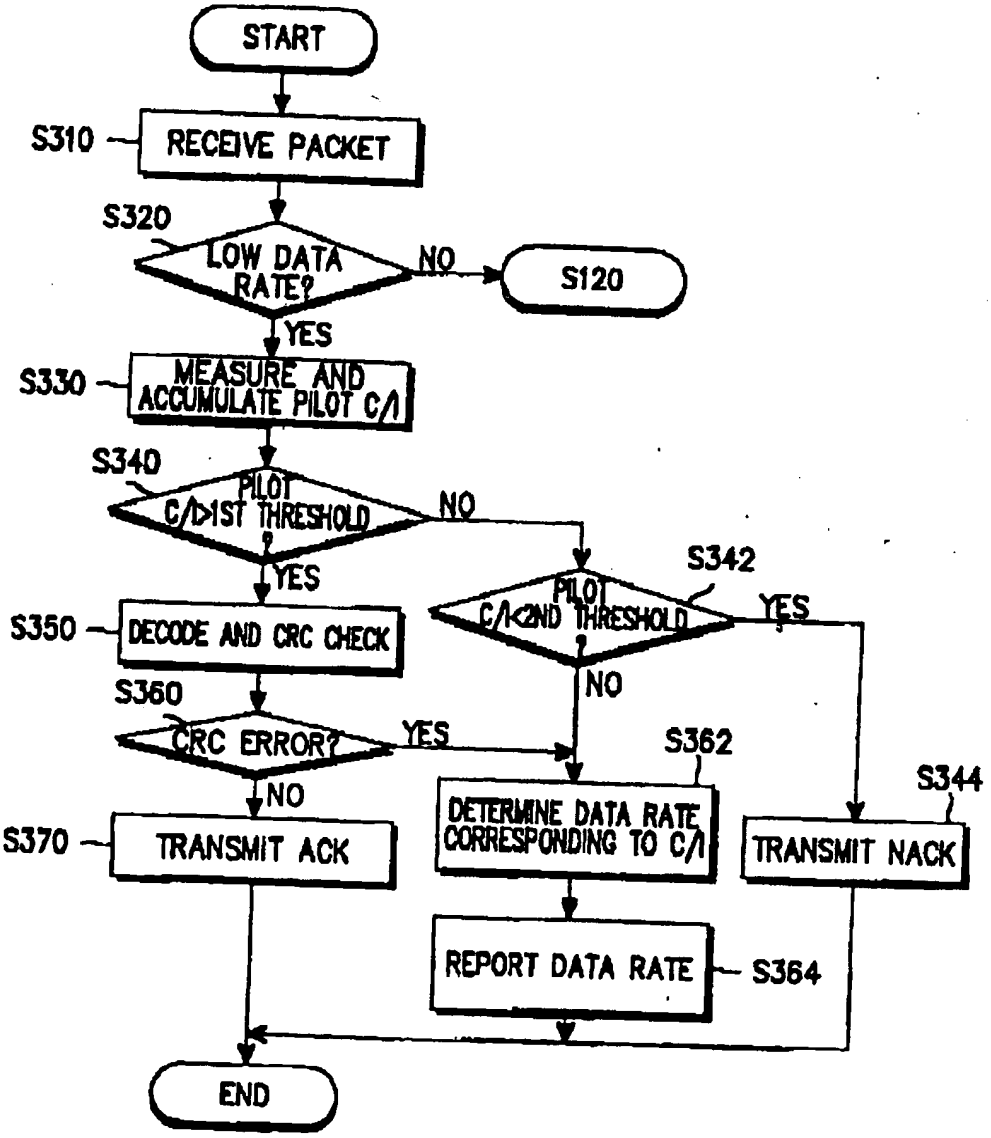

START
S310
RECEIVE PACKET
S320
LOW DATA RATE?
NO
S120
YES
S330
MEASURE AND ACCUMULATE PILOT C/I
S340
PILOT C/I>1ST THRESHOLD
NO
YES
S342
PILOT C/I<2ND THRESHOLD
YES
NO
S350
DECODE AND CRC CHECK
S360
CRC ERROR?
YES
NO
S362
DETERMINE DATA RATE CORRESPONDING TO C/I
S344
TRANSMIT NACK
S370
TRANSMIT ACK
REPORT DATA RATE
S364
END

FIG. 5

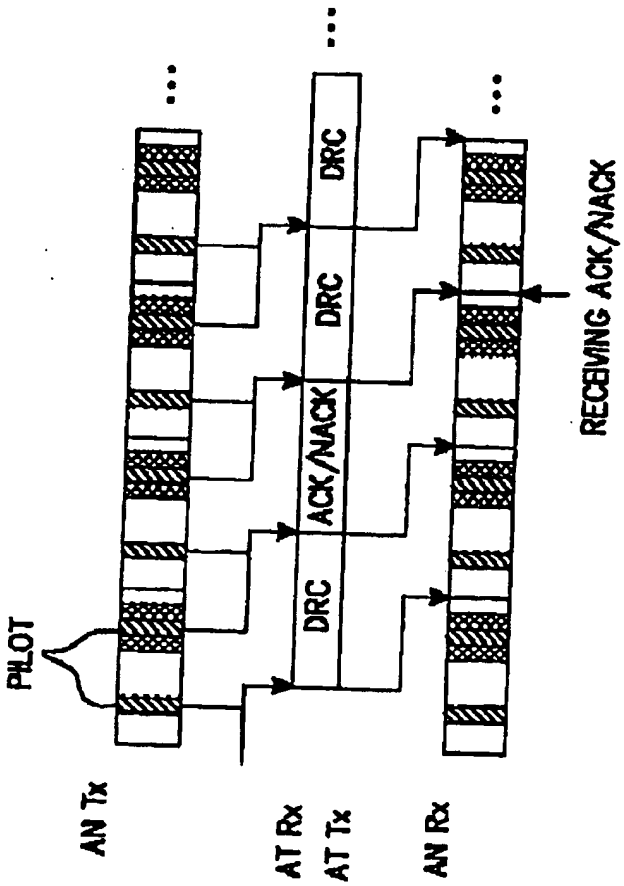

PILOT
DRC
ACK/NACK
DRC
DRC
RECEIVING ACK/NACK
AN Tx
AT Rx
AT Tx
AN Rx

FIG. 6

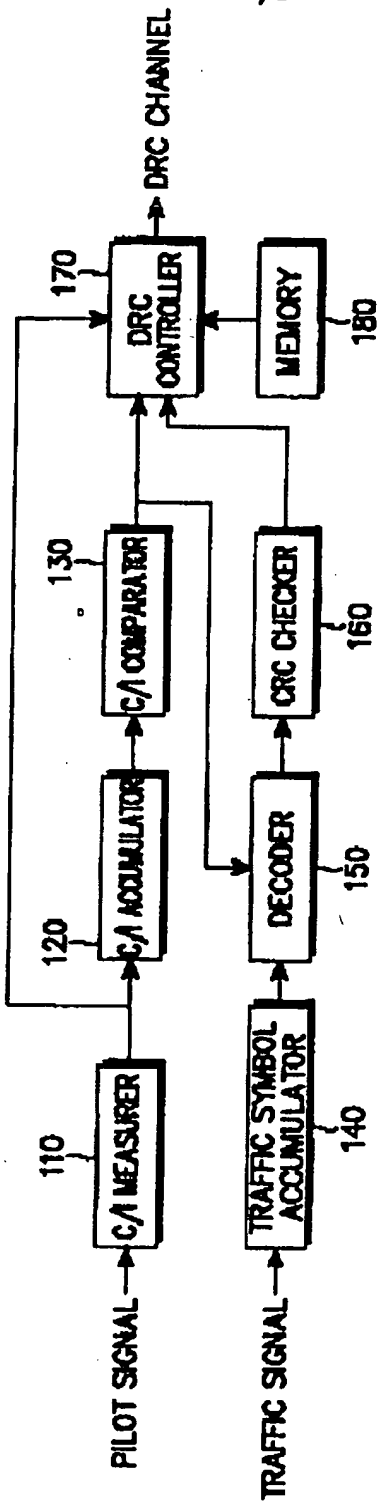

PILOT SIGNAL
TRAFFIC SIGNAL
C/I MEASURER
110
C/I ACCUMULATOR
120
C/I COMPARATOR
130
TRAFFIC SYMBOL ACCUMULATOR
140
DECODER
150
CRC CHECKER
160
DRC CONTROLLER
170
MEMORY
180
DRC CHANNEL

FIG. 7

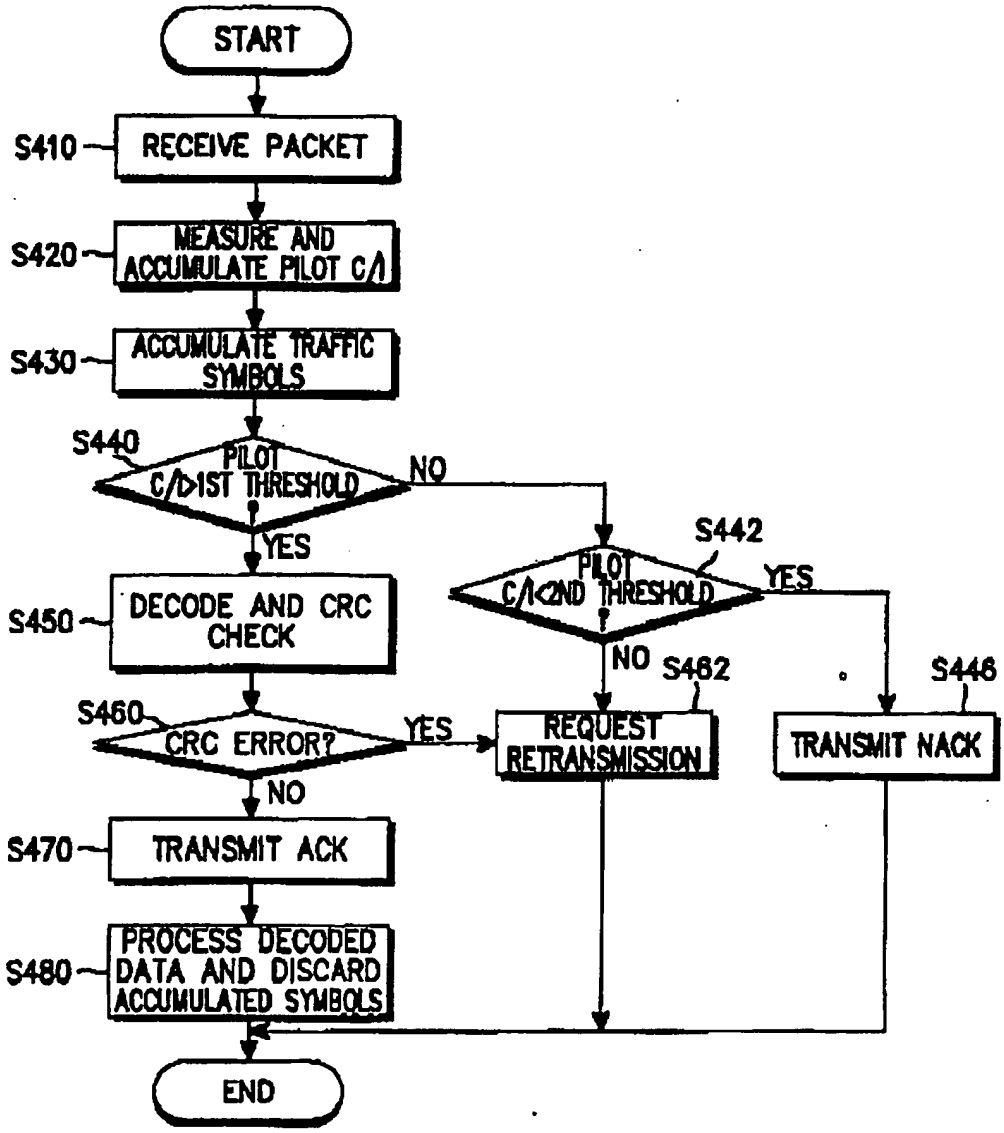

START
S410
RECEIVE PACKET
S420
MEASURE AND ACCUMULATE PILOT C/I
S430
ACCUMULATE TRAFFIC SYMBOLS
S440
PILOT C/I>1ST THRESHOLD
NO
YES
S442
PILOT C/I<2ND THRESHOLD
YES
NO
S450
DECODE AND CRC CHECK
S460
CRC ERROR?
YES
NO
S462
REQUEST RETRANSMISSION
S446
TRANSMIT NACK
S470
TRANSMIT ACK
S480
PROCESS DECODED DATA AND DISCARD ACCUMULATED SYMBOLS
END

FIG. 8

對外秘

직무발명신고

<<특허법 제39조 제40조 규정에 의거 직무와 관련된 본발명에 대해 등록받을 수 있는 권리를 회사에 양도합니다>>

■ 본 직무발명은 통신연구소 지적자산팀(수원/구미)으로 접수됩니다.

■ 발명명칭 이동통신시스템의 링크적응방식 및 ARQ 방식의 리율 및 전력효율을 개선하기 위한 방법

■ 과제명 cdma2000 상용화 과제 ■ 과제코드 DN901 ■ 제품명 -

■ 핵심기술(코드)명칭)

■ 기술적 내용의 평가

구분	평가내용					
발명구분	◉ 자체발명 산학협동 용역개발 공동개발					
계약서관리	[계약서 첨부] 파일명 / 파일설명 [소유권, 보상문제 기재]					
공표사실	공표예정일	-	공표국가 및 단체	-	공표방법	-

■ 발명자인적사항

No.	사외	이 름	소속부서(기관)명 / 주민번호	대표	지분(%)	영문성명 / 주 소 (집)	한자성명
1		허훈	cdma2000시스템개발팀	⊙	25	HUH HOON	허훈
			740817-1448823	경기도 성남시 분당구 서현동 한양APT 333-608			
2		강희원	cdma2000시스템개발팀	-	15	KANG HEE WON	姜熙原
			680119-1051636	서울특별시 서초구 반포동 한신6차아파트 216-413			
3		양상현	cdma2000시스템개발팀	-	15	YANG SANG HYUN	梁相賢
			720614-1836218	경기 안양시 동안구 평촌동 향촌현대4차 208 동 503호			
4		염재흥	cdma2000시스템개발팀	-	15	YEOM JAE HEUNG	廉再興
			690704-1074418	서울특별시 강남구 일원1동 677-11 B2			
5		윤순영	cdma2000시스템개발팀	-	15	YOON SOON YOUNG	尹淳暎
			660112-1552723	서울특별시 송파구 잠실7동 아시아선수촌아파트 9동 106호			
6		윤유석	cdma2000시스템개발팀	-	15	YUN YU SUK	尹裕晳
			711019-1462135	서울특별시 강남구 대치1동 삼성아파트 111동 103호			

■ 직무발명신고파일

파일명	파일설명
LinkAdapt.hwp	발명 명세서
발명신고서1.gul	발명 신고서

■ 발명등급판정

판정주체		판정일자	등급	의견
발명자	허훈	2000/05/19	A급	연구 개발과 연계된 기술로써 실현 가능성이 높은 응용 기술
부서장	정중호	2000/05/19	A급	HDR관련 기술로 표준화 예정임
특허부서		2000/05/24	B급	전산일괄입력
평가위원회		2000/09/01	A급	전산일괄입력

■ 직무발명 진행일자 관리

발명자상신일	2000/05/19	부서장승인일	2000/05/19	특허부서접수일	2000/05/22

직무발명 접수번호 : GC-200005-079-1

【요약서】

【요약】

본 발명은 이동통신시스템을 채널의 상태에 적응시키는 방식에 관한 것으로, 링크적응(Link Adaptation)방식의 패킷반복전송 및 ARQ(Automatic Repeat reQuest) 및 hybrid ARQ 등의 패킷 재전송에서 파일럿 심볼 또는 파일럿 채널의 수신 C/I(Carrier to Interference ratio)값을 이용하여 복호화 및 CRC(Cyclic Redundancy Check) 검사 여부를 결정하고 검사결과에 따라 ACK(Acknowlodgment)와 NACK(Negative ACK), 재전송 요구신호를 귀환시켜 채널의 처리율(Throughput) 증가, 전력소비 감소 및 귀환지연시간 단축으로 인한 송신기의 기억장치 요구량 감소 등을 가능하게 한다. 파일럿의 수신 C/I 값이 복호화 후 패킷 오류확률을 일정한 값 이하로 보장하는 상위 임계치를 넘는 경우에는 복호화하여 CRC를 검사하고 CRC 검사 결과 패킷 오류가 없는 경우 송신기에 ACK를 전송해 반복 또는 재전송을 멈추도록 하고, 그렇지 않으면 반복전송 또는 재전송을 요구한다. 또한 이 파일럿 C/I 값이 최대반복전송 횟수만큼 재전송하여 결합한다고 하더라도 패킷 오류가 있을 것이 확실시 되는 하위 임계치보다 작은 경우 NACK를 송신기에 전송하여 전송을 아예 포기하거나 반복전송 및 재전송을 포기하고 패킷을 처음부터 다시 전송하도록 하며 파일럿 C/I 값이 상위 임계치와 하위 임계치의 중간값일 경우에는 반복 또는 재전송을 요구한다.

【대표도】

도 6, 도 7

【색인어】

링크적응방식(Link Adaptation), ARQ, hybrid ARQ, ACK, NACK

【발명의 명칭】

이동통신시스템의 링크적응방식 및 ARQ 방식의 처리율 및 전력효율을 개선하기 위한 방법 {METHOD FOR IMPROVING THE THROUGHPUT AND POWER EFFICIENCY OF LINK ADAPTATION SCHEME AND ARQ SCHEME IN MOBILE COMMUNICATION SYSTEM}

【도면의 간단한 설명】

도 1은 HDR 순방향 및 역방향 링크의 슬롯 송수신 타이밍을 나타낸 도면.

도 2은 HDR 시스템에서 단말기가 기지국에 데이터 전송속도를 요구하는 알고리듬을 순서도로 나타낸 도면.

도 3는 HDR 순방향 데이터 전송율에 따른 패킷 길이를 나타낸 도면.

도 4는 hybrid ARQ에서 오류가 발생했을 때 재전송을 요구하는 알고리듬을 순서도로 나타낸 도면.

도 5는 본 발명의 첫 번째 실시예에 따른 HDR 순방향 및 역방향 링크의 슬롯 송수신 타이밍을 나타낸 도면.

도 6은 본 발명의 첫 번째 실시예에 따른 HDR 시스템에서 단말기가 기지국에 데이터 전송속도를 요구하거나 및 ACK, NACK를 전송하는 알고리듬을 순서도로 나타낸 도면.

도 7은 본 발명의 두 번째 실시예에 따른 1Xtreme 시스템의 hybrid ARQ에서 ACK와 NACK를 전송하는 알고리듬을 순서도로 나타낸 도면.

【발명의 상세한 설명】

【발명의 목적】

【발명이 속하는 기술분야 및 그 분야의 종래기술】

본 발명은 이동통신시스템을 채널의 상태에 적응시키는 방식에 관한 것으로, 링크적응(Link Adaptation)방식과 ARQ(Automatic Repeat reQuest) 및 hybrid ARQ 방식의 개선에 관한 것이다.

이동통신채널은 거리 및 음영에 따라 전파경로의 감쇠량이 변화하고 시스템간 간섭 및 페이딩이 심하여 채널의 상태에 따른 수신 신호 대 간섭비(Carrier to inference ratio : 이하 C/I라 칭한다.)의 변화가 크다. 링크적응방식은 채널상태에 따라서 전송 데이터량을 조절하여 채널의 처리율(Throughput)을 높이고자 하는 것이다. 링크적응방식에서는 부호화율(Coding Rate) 및 변조방식을 선택하여 채널상태가 좋을 때는 데이터 전송율을 높이고, 채널상태가 나쁠 때는 데이터 전송율을 낮춘다. 데이터 전송율은 채널의 상태에 따라 일정한 신뢰도로 통신이 가능한 부호화율과 변조 방식에 따라 정하며, 수신 C/I가 클 때는 높은 부호화율의 부호와 고수준의 변조 방식을 사용하여 데이터 전송율을 높이고, 수신 C/I가 작을 때는 낮은 부호화율의 부호와 저수준의 변조 방식을 사용하여 데이터 전송율을 낮추며 대신 채널의 신뢰도를 높인다. 수신기에서는 수신 C/I를 바탕으로 다음 채널의 변화를 예측하여 결정한 데이터 전송율을 송신기로 귀환시키거나 수신 C/I값 자체를 송신기로 귀환시키며 수신 C/I 값을 귀환시키는 경우에는 기지국에 데이터 전송율을 결정한다. 링크적응방식은 적응적 부호화 및 변조(Adaptive Coding and Modulation)방식이라고도 한다.

이와 달리, 수신된 패킷(Packet)의 CRC(Cyclic Redundancy Check)를 검사하여 오류가 있을 때에 송신기에 재전송을 요구하도록 하는 ARQ(Automatic Repeat reQuest) 방식이 있다. ARQ에서는 채널상태가 좋지 않을 때에는 재전송을 요구하여 패킷을 반복해 전송하게 하므로 실질적인 데이터 전송율은 낮추고 채널의 신뢰도를 높여 채널에 적응시키는 방식이다. 오류정정부호(Error Correcting Code)와 함께 사용하여 재전송시 부호화율을 낮추거나 재전송된 패킷들을 결합하여 복호화(Decoding)하는 hybrid ARQ 방식도 있다.

위의 링크적응방식에서는 수신신호의 C/I에 따라 부호화율과 변조 방식이 결정된다. 일반적으로 트래픽 채널의 수신 C/I는 대부분 파일럿 심볼 또는 파일럿 채널의 수신 C/I를 이용한다. 수신 C/I가 낮을 때에는 낮은 부호화율 및 저수준의 변조방식을 선택하고 동시에 비트 에너지 대 잡음비를 높이기 위해 같은 패킷을 반복 전송하여 수신측에서는 반복된 패킷들을 결합하기도 한다. 예를

들면 Qualcomm사의 HDR air interface specification에는 38.4kbps에서는 패킷을 16회 반복해서 보내도록 되어있다. 이러한 반복 전송으로 인하여 패킷 전송시간이 길어지면 채널 예측의 오차가 커지므로 채널의 변화에 따라 부호화율 및 변조 방식이 신속하게 변화하지 못한다. 또한 낮은 전송율의 패킷이 전송시간이 길어 자원을 오래 점유하므로 전체적인 채널의 처리율을 낮게 만든다.

다음에서는 이동통신시스템의 실례를 들어 설명한다. IS-2000의 데이터 통신 보완을 위해 3GPP2(3rd Generation Partnership Project 2) 에 제안된 HDR(High Data Rate) 규격의 순방향 링크를 기반으로 하여 설명한다. 위에서 언급한 송신기는 기지국(Access Network)이 되고 수신기는 단말기(Access Terminal)가 된다. 링크적응방식에 따른 HDR의 물리계층은 QPSK(Quadrature Phase Shift Keying), 8PSK(8-ary Phase Shift Keying), 및 16QAM(16-ary Phase Shift Keying)등 3가지의 변조방식과 1/4, 3/8, 및 1/2의 3가지 부호화율, 그리고 패킷이 반복되는 슬롯수의 조합으로 13가지의 전송방식이 있다. 도 1은 HDR 순방향 및 역방향 링크의 슬롯 송수신 타이밍을 나타낸 도면이다. 송신 패킷의 구조는 한 슬롯당 2048 칩으로 구성되어 있고 변조방식은 전송율에 따라 QPSK, 8PSK, 16QAM등을 사용한다. 도 1에서와 같이 반 슬롯에 하나씩 두 개의 파일럿 채널에 각각 96 칩이 할당된다. 파일럿 심볼은 항상 트래픽 채널과 동일한 전력으로 전송되므로 파일럿 채널의 C/I로 트래픽 채널의 C/I를 측정할 수 있다.

도 2에서는 HDR에서 단말기가 기지국에 데이터 전송속도를 요구하는 알고리듬을 순서도로 나타내고 있다. 단말기에서는 매 슬롯마다 프리앰블(Preamble)을 검색하여 자기에게 수신된 정보인지를 확인한다. 자기에게 수신된 패킷임이 확인되면 프리앰블의 길이를 검사하여 자신이 요구한 전송속도인지 확인한다. 이것이 확인되면 패킷에서 파일럿 채널에 대해 측정한 C/I값을 이용하여 수신할 수 있는 데이터 속도를 결정해 송신기에 귀환 전송한다. 이때 귀환 전송되는 채널을 DRC(Data Rate Control) 채널이라고 한다. 도 3에서는 HDR의 순방향 데이터 전송율에 따른 패킷 길이를 나타낸다. 슬롯의 수만큼 패킷이 반복하여 전송된다. 데이터 전송률 38.4 kbps에서는 한 패킷이 16 슬롯에 걸쳐 반복 전송되고 76.8 kbps에서는 한 패킷이 8 슬롯에 걸쳐 반복 전송되도록 되어있다. 반면에 부호화율 1/2의 부호와 8PSK를 사용하는 1843.2kbps와 부호화율 1/2의 부호와 16QAM을 사용하는 2457.6kbps 는 1슬롯에 전송된다. 따라서 데이터 전송율이 낮은 경우 패킷의 길이가 길어서 채널변화에 따라 전송방식의 변화가 신속하게 이루어지지 못하므로 무선 자원의 낭비를 가져온다. 또한 HDR 순방향 링크에서는 사용자간 시분할(Time division multiplexing)하여 전송하므로 낮은 전송율의 사용자가 많은 슬롯을 점유할 경우 전체적인 처리율이 매우 작아지는 문제가 있다.

다음에서는 IS-2000의 데이터 통신 보완을 위해 3GPP2(3rd Generation Partnership Project 2) 에 제안된 1Xtreme 규격의 ARQ 및 hybrid ARQ를 실례로 들어 설명한다. 도 4는 hybrid ARQ에서 오류발생시 재전송을 요구하는 알고리듬을 순서도로 나타내었다. 수신기에서 패킷을 수신하면 이전에 수신한 동일 패킷이 존재하는지 확인하여 존재하면 이와 결합한다. 결합된 신호를 복호화하여 CRC 를 검사하고 검사결과 오류가 없으면 송신기에 ACK를 전송하고 오류가 있으면 재전송을 요구한다. ARQ와 hybrid ARQ는 재전송 여부를 결정하기 위해서는 수신 패킷을 복호화(Decoding)하여 CRC를

검사하는 과정을 거친다. 채널의 상태가 매우 나쁠 때에는 복호화 후 CRC 검사과정에서 계속적으로 오류를 검출할 가능성이 크고 이에 따라 재전송을 계속 요구하게 된다. 이 과정에서 반복적인 복호화에 불필요하게 많은 전력을 소모하게 되고 복호화에 걸리는 시간만큼 귀환지연시간이 증가한다. 계속적인 재전송을 요구하고 귀환시간이 지연되면 송신기에서 또한 많은 수의 패킷을 계속 저장해야 하고 따라서 대용량의 기억장치를 필요로 하게 된다. ARQ 및 hybrid ARQ 는 채널의 상태에 자동적으로 적응하도록 되어있지만, 패킷에 오류가 있을 가능성이 높을 때도 패킷을 수신할 때마다 복호화과정을 거치므로 이에 따른 전력 소비와 지연, 그리고 채널의 상태가 매우 나쁠 때에 대비해 필요한 기억장치의 용량이 커진다는 단점이 있다.

결론적으로 채널상태에 따라 전송방법 및 전송횟수를 바꾸어 채널에 적응하도록 하여 처리율을 높이기 위한 방법으로 링크적응방법 및 ARQ 와 hybrid ARQ 등이 있는데, 채널의 상태가 좋지 않을 때 링크적응방법은 패킷 반복전송에 따른 처리율을 감소시키는 단점이 있고, ARQ 및 hybrid ARQ 는 계속 재전송을 요구하며 복호화를 반복함에 따라 전력이 낭비되고 지연시간이 증가하며 기억장치에 대한 요구가 증가한다는 단점이 있다.

【발명이 이루고자 하는 기술적 과제】

따라서, 상기한 바와 같은 문제점을 해결하기 위한 본 발명의 목적은 이동통신시스템에 사용되는 링크적응방식과 ARQ 및 hybrid ARQ방식에서 채널에 적응하는 속도를 빠르게 하여 처리율을 향상시킬 수 있는 방법을 제공함에 있다.

본 발명의 다른 목적은 링크적응방식과 ARQ 및 hybrid ARQ방식에서 복호화 한 뒤 CRC 를 검사하기 이전에 복호화 여부를 결정하고 재전송 또는 재전송 중지 등을 요구할 수 있도록 하여 전력소비 및 귀환시간 지연, 기억장치 용량을 줄일 수 있는 방법을 제공함에 있다.

상기한 목적을 달성하기 위해 본 발명은 링크적응방식의 패킷반복전송 및 ARQ와 hybrid ARQ에서의 패킷 재전송에서 파일럿 채널 또는 파일럿 심볼의 C/I를 측정하여 이 값이 복호화 후 패킷오류확률을 일정한 값 이하로 보장하는 상위 임계치를 넘을 경우 복호화하고 그렇지 않을 경우 재전송 또는 반복전송을 요구한다. 또한 이 파일럿 C/I 값이 복호화한 뒤 오류가 있을 것이 확실시되는 하위 임계치를 넘는 경우 전송을 아예 포기하거나 재전송 및 반복전송을 포기하고 패킷을 처음부터 다시 전송하도록 하는 방법을 구현하였다.

【발명의 구성 및 작용】

이하 본 발명의 실시 예를 첨부된 도면을 참조하여 상세히 설명한다.

첫 번째 실시 예는 다음과 같다. 도 5는 본 발명의 기본적 구조를 담고 있는 도면으로 본 발명을 적용한 HDR 시스템의 순방향 및 역방향 링크의 슬롯 송수신 타이밍을 나타낸다. 송신기에서 패킷전송을 마치면 수신기에서 이를 수신하여 복호화한 뒤 수신 패킷에 대한 CRC를 검사하고 이에 대한 결과를 DRC 외에 ACK 및 NACK 등으로 귀환시킨다. 본 발명에서의 ACK 또는 NACK의 의미는 일반

적인 ARQ에서의 의미와 다를 수 있다. 본 발명에서의 ACK는 수신신호의 복호화 후에 오류가 없음을 확인하여 반복전송 또는 재전송을 멈출 것을 요구하는 신호이고, NACK는 수신신호를 재전송 및 반복전송하여도 오류가 계속 존재할 것이 확실시되므로 반복전송 및 재전송을 멈출 것을 요구하는 신호이다.

그러나 복호화 및 수신 패킷에 대한 CRC 검사는 매 번 수행하는 것이 아니고 일반적으로 패킷에 시분할하여 전송되는 파일럿 심볼이나 별도의 채널로 전송되는 파일럿 채널의 C/I를 측정하여 복호화 및 CRC 검사여부를 결정한다. 파일럿의 수신 C/I 값이 복호화 후 패킷오류확률을 일정한 값 이하로 보장하는 상위 임계치를 넘는 경우에는 복호화하여 CRC를 검사한다. 패킷이 반복전송 또는 재전송된 경우에는 각 패킷의 파일럿 C/I를 누적한 값을 사용한다. CRC 검사결과 패킷 오류가 없는 경우 송신기에 ACK를 전송하여 반복 또는 재전송을 멈추도록 하고, 그렇지 않으면 반복전송 또는 재전송을 요구한다. 또한 이 파일럿 C/I값 또는 누적값이 최대반복전송 횟수만큼 재전송하여 결합한다고 하더라도 패킷 오류가 있을 것이 확실시되는 하위 임계치보다 작은 경우 NACK를 송신기에 전송하여 전송을 아예 포기하거나 반복전송 및 재전송을 포기하고 패킷을 처음부터 다시 전송하도록 하며 파일럿 C/I 값이 상위 임계치와 하위 임계치의 중간값일 경우에는 반복 또는 재전송을 요구한다.

도 6은 HDR 시스템에서 단말기가 DRC 및 ACK, NACK 를 사용하여 기지국에 데이터 전송속도를 요구하거나 및 반복전송의 중단을 요구하는 알고리듬의 순서도를 나타낸다. 기지국에서는 단말기로부터 ACK 또는 NACK를 받을 경우 현재의 패킷 전송을 중단한다. 그렇지 않을 경우에는 기지국은 단말기가 요구하는 데이터 전송속도로 패킷을 계속 전송한다. 단말기는 매 슬롯마다 프리앰블을 검색하여 자신에게 전송된 패킷인지 확인한다. 자기에게 수신된 패킷임이 확인되면 프리앰블의 길이를 검사하여 패킷이 두 슬롯 이상에 반복 전송되는 저속 데이터 전송율인지 확인한다. 반복전송이 없는 고속 데이터 전송율인 경우에는 파일럿 C/I를 측정하여 DRC 만 기지국으로 전송한다. 저속 데이터 전송율인 경우에는 단말기는 파일럿 C/I를 측정하고 이전에 반복된 C/I값이 존재하면 이 값과 누적하여 상위 임계치 및 하위 임계치와 비교한다. 누적된 파일럿 C/I 값이 상위 임계치보다 클 경우에는 복호화를 수행하고 CRC를 검사한다. CRC 검사 후 오류가 없는 경우에는 기지국에 ACK를 전송하여 반복전송을 중단시키고 오류가 있는 경우에는 기지국에 DRC를 전송하여 계속 반복전송하게 한다. 만약 C/I 측정이 정확하다면 복호화 및 CRC 검사과정을 생략하고 ACK를 바로 전송할 수 있다. 반면 누적된 파일럿 C/I 값이 다른 하위 임계치 값과 비교하여 이보다 작을 경우 복호화를 포기하고 기지국에 NACK를 보내 반복 전송을 중단시킨다. 하위 임계치는 파일럿 C/I값 또는 누적 값이 패킷 길이만큼 반복전송하여 결합한다고 하더라도 패킷 오류가 있을 것이 확실시되는 값으로 반복전송횟수에 따라 각각 다른 값을 갖는다. 표 1은 4 비트의 DRC 심볼과 데이터 전송율 및 ACK, NACK의 대응관계의 한 예이다.

【표 1】

4-bit DRC symbol	전송속도 및 ACK/NACK
0000	38.4 kbps
0001	76.8 kbps
0010	102.4 kbps
0011	153.6 kbps (short)
0100	153.6 kbps (long)
0101	204.8 kbps
0110	307.2 kbps (short)
0111	307.2 kbps (long)
1000	614.4 kbps
1001	921.6 kbps
1010	1228.8 kbps
1011	1843.2 kbps
1100	2457.6 kbps
1101	ACK
1110	
1111	NACK

표 1에서 short는 짧은 패킷, long은 긴 패킷 전송을 나타내고, 16개의 DRC 심볼 가운데 남는 1101과 1111을 ACK와 NACK 에 대응시킨다.

두 번째 실시예는 다음과 같다. 도 6은 ACK와 NACK를 사용한 1Xtreame 의 hybrid ARQ 동작 알고리듬에 관한 순서도를 나타낸다. 기지국에서 단말기로 패킷이 수신되면 파일럿 채널의 C/I를 측정하고 이전의 누적 파일럿 C/I가 존재하면 이 값에에 누적시킨다. 트래픽 채널의 심볼도 이전에 전송된 동일한 패킷이 존재하면 동일 심볼끼리 결합시킨다. 누적 파일럿의 C/I 값이 상위 임계치보다 큰 경우에 한해서 결합된 트래픽 심볼에 대해 복호화 및 CRC 검사를 한다. CRC 검사결과 패킷 오류가 없음이 확인되면 ACK를 기지국으로 귀환전송하여 더 이상 재전송을 하지 않도록 하고, 패킷 오류가 발견되면 기지국에 재전송을 요구한다. 오류가 없는 패킷은 상위 단계로 올리고 복호화된 데이터 및 누적 파일럿 C/I를 삭제한다. 반면 누적 C/I가 상위 임계치보다 작으면 하위 임계치와 비교하여 하위 임계치보다 크면 패킷 재전송을 요구하고 하위 임계치보다도 작으면 NACK를 전송하여 재전송을 포기하고 처음부터 새로 전송하거나 자원을 다른 사용자에게 할당한다. 하위 임계치는 파일럿 C/I값 또는 누적 값이 최대 재전송횟수만큼 재전송하여 결합한다고 하더라도 패킷 오류가 있을 것이 확실시되는 값으로 재전송횟수에 따라 각각 다른 값을 갖는다. 기존의 ARQ 또는 hybrid ARQ와 달리 복호화 이전에 C/I 값을 비교함으로써 불필요한 복호화 및 CRC 검사과정을 미리 한번 여과시키므로써 전력의 소비 및 귀환 지연시간의 증가, 송신기 기억장치 용량요구 증가 등을 줄일 수 있다.

【발명의 효과】

상술한 바와 같이 본 발명은 링크적응방식의 반복전송 및 ARQ 또는 hybrid ARQ의 재전송 요구시에 C/I 측정결과를 이용하여 패킷오류확률을 일정수준으로 유지할 수 있을 때 복호화를 수행하고 CRC를 검사하므로써 채널의 처리율 증가, 전력소비 감소 및 송신기의 기억장치 요구량 감소 등을

가능하게 한다.

【특허청구범위】

【청구항 1】

링크적응방식을 사용하는 이동통신시스템에 있어서,

상기한 패킷이 반복 전송되는 저속의 전송율에서 패킷이 전송될 때마다 복호화 및 CRC 검사를 통하여 패킷을 계속 반복 전송할 필요가 있는지 여부를 송신기에 전송하는 방식과

매회 복호화를 할 필요 없이 복호화 이전에 수신 파일럿 C/I 측정을 통해 패킷 오류확률이 일정한 값 이하가 될 때에만 복호화 및 CRC 검사를 하도록 하는 수신기 구조.

【청구항 2】

제 1항의 상기 수신기에 있어서,

매회 복호화 이전에 수신 파일럿 C/I 측정을 통해 패킷의 오류가 확실하게 예측되는 경우 패킷을 계속 반복 전송할 필요가 없음을 송신기에 전송하는 방식 및 수신기 구조.

【청구항 3】

ARQ 또는 hybrid ARQ 방식을 사용하는 이동통신시스템에 있어서,

상기 처음 전송 또는 재전송 패킷에 대해 복호화 이전에 수신 파일럿 C/I 측정을 통해 패킷 오류확률이 일정한 값 이하가 될 때에만 복호화 및 CRC 검사를 하도록 하는 방식 및 수신기 구조.

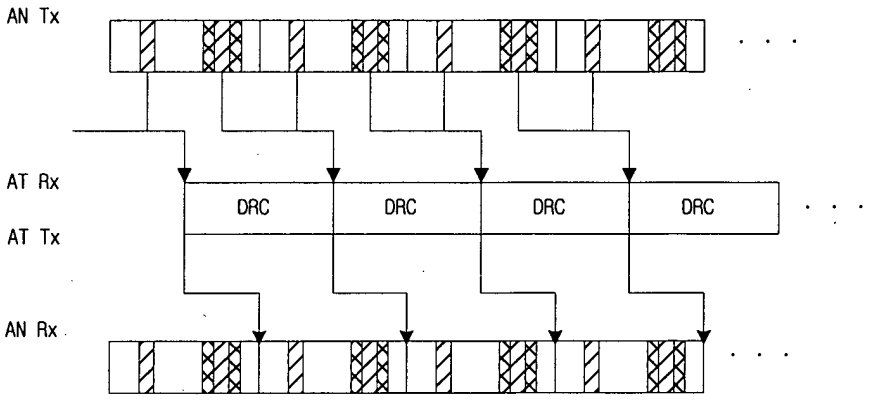
【청구항 4】

제 3항의 상기 수신기에 있어서,

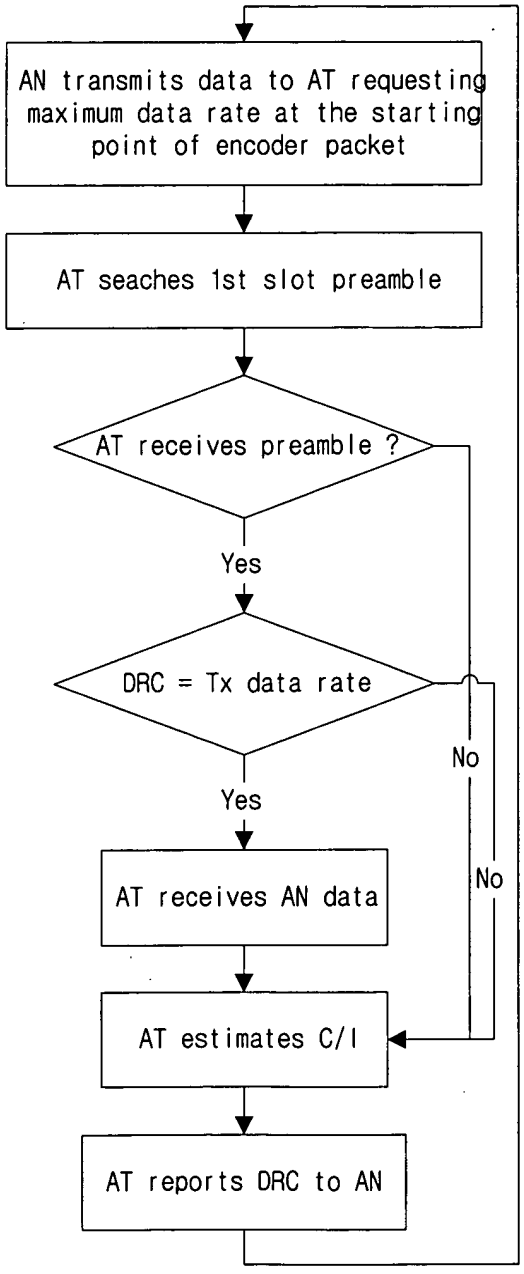
상기 처음 전송 또는 재전송 패킷에 대해 복호화 이전에 C/I 측정을 통해 패킷의 오류가 확실하게 예측되는 될 경우 패킷을 계속 반복 전송할 필요가 없음을 송신기에 전송하는 방식 및 수신기 구조.

【도면】

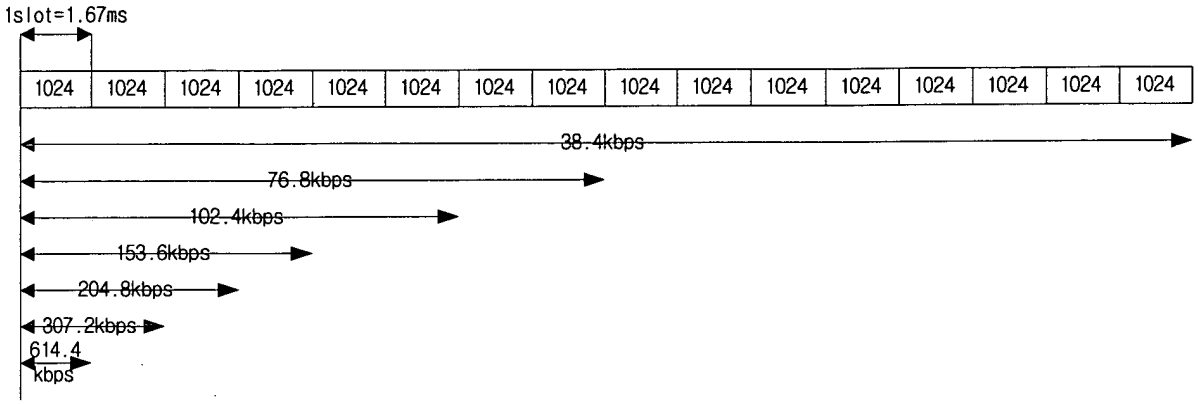
【도 1】



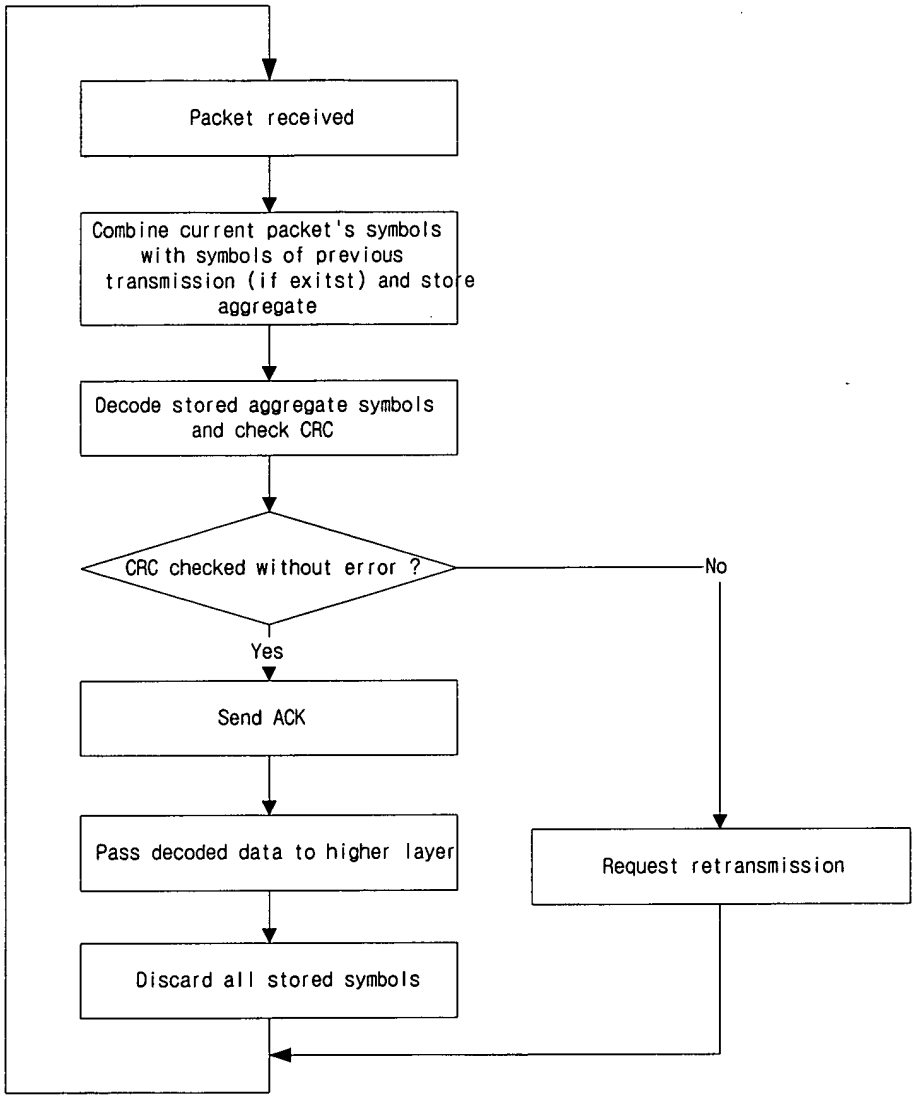
【도 2】


AN transmits data to AT requesting maximum data rate at the starting point of encoder packet
AT seaches 1st slot preamble
AT receives preamble ?
Yes
No
DRC = Tx data rate
Yes
No
AT receives AN data
AT estimates C/I
AT reports DRC to AN

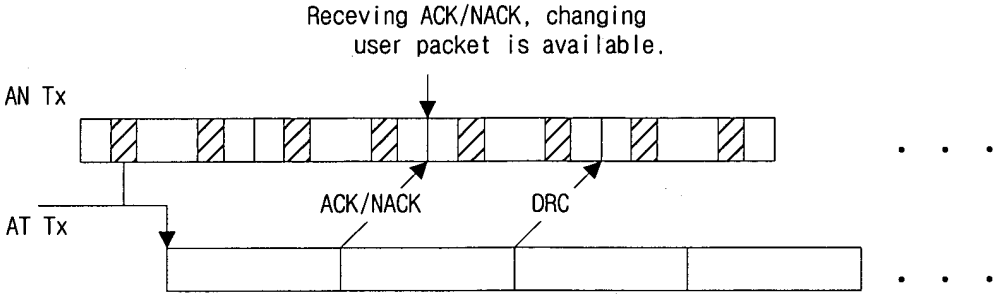
【도 3】


1slot=1.67ms
1024
1024
1024
1024
1024
1024
1024
1024
1024
1024
1024
1024
1024
1024
1024
38.4kbps
76.8kbps
102.4kbps
153.6kbps
204.8kbps
307.2kbps
614.4
kbps

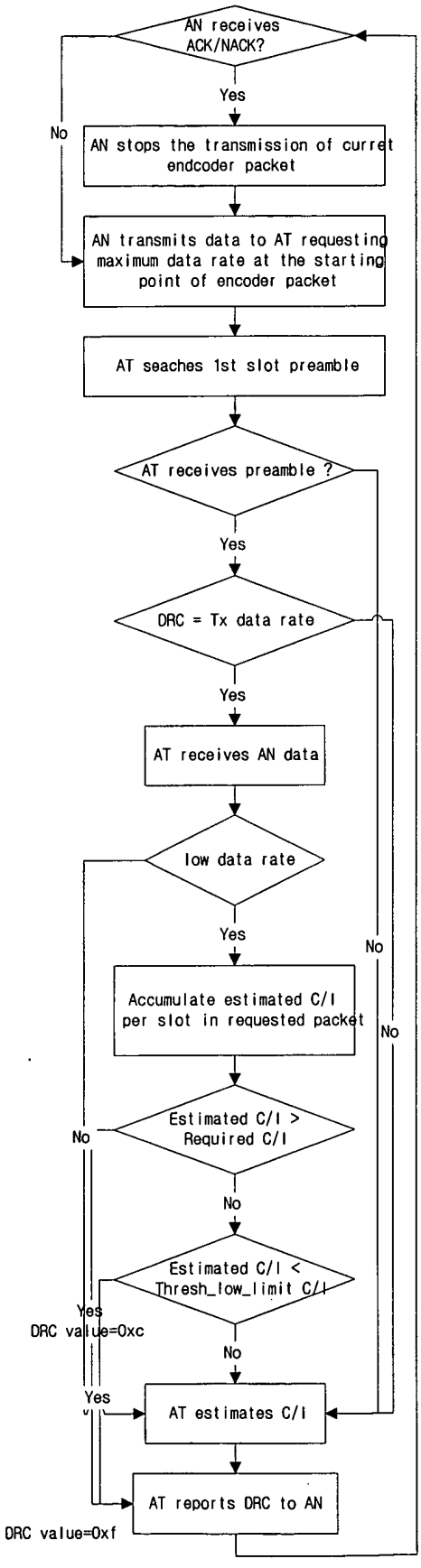
【도 4】


Packet received
Combine current packet's symbols with symbols of previous transmission (if exitst) and store aggregate
Decode stored aggregate symbols and check CRC
CRC checked without error ?
No
Yes
Send ACK
Pass decoded data to higher layer
Request retransmission
Discard all stored symbols

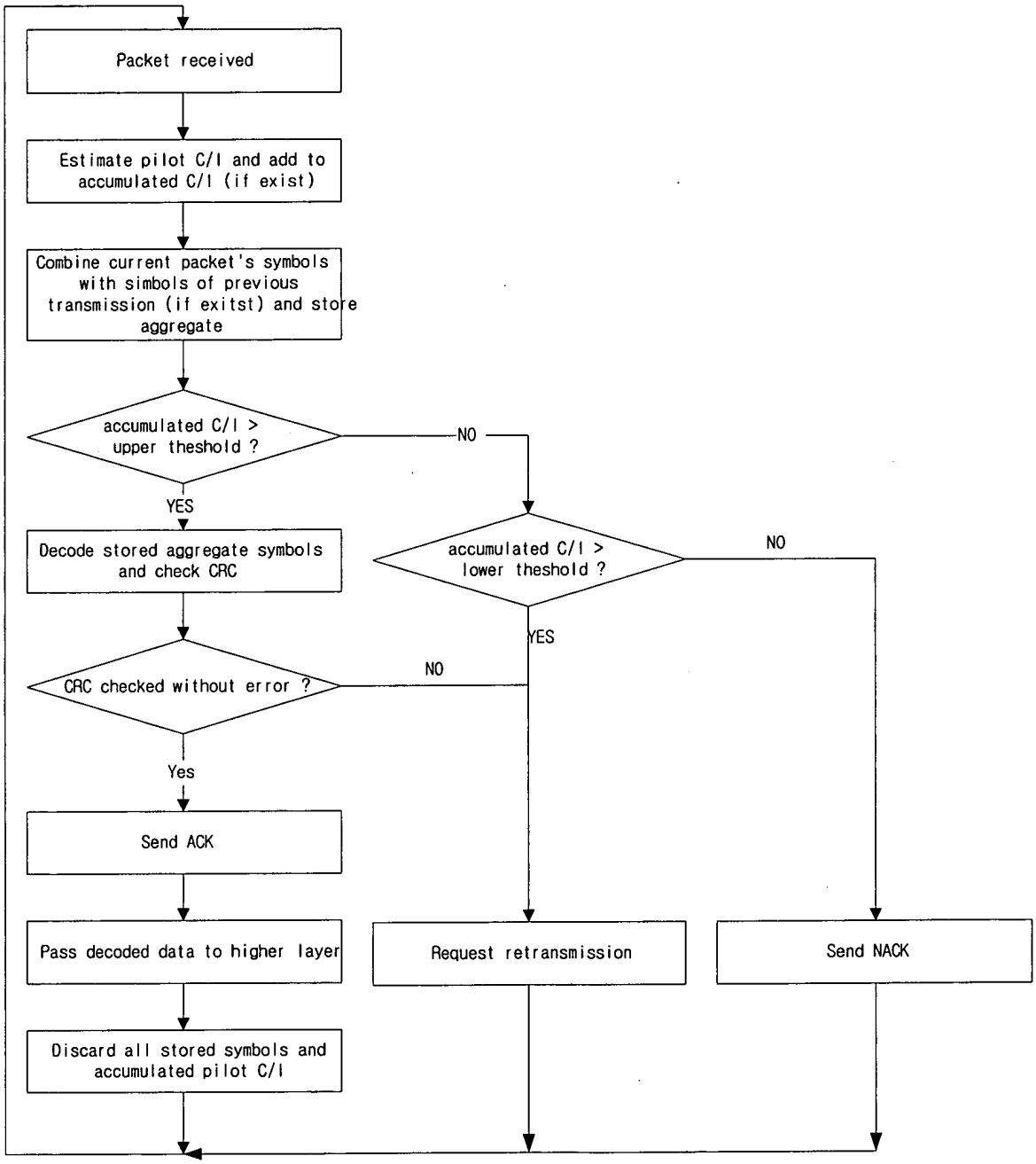
【도 5】


Receving ACK/NACK, changing
user packet is available.
AN Tx
AT Tx
ACK/NACK
DRC

【도 6】


AN receives ACK/NACK?
Yes
No
AN stops the transmission of curret endcoder packet
AN transmits data to AT requesting maximum data rate at the starting point of encoder packet
AT seaches 1st slot preamble
AT receives preamble ?
Yes
DRC = Tx data rate
Yes
AT receives AN data
low data rate
Yes
No
Accumulate estimated C/I per slot in requested packet
No
Estimated C/I > Required C/I
No
No
Estimated C/I < Thresh_low_limit C/I
Yes
DRC value=0xc
No
Yes
AT estimates C/I
AT reports DRC to AN
DRC value=0xf

【도 7】


Packet received
Estimate pilot C/I and add to accumulated C/I (if exist)
Combine current packet's symbols with simbols of previous transmission (if exitst) and store aggregate
accumulated C/I > upper theshold ?
NO
YES
Decode stored aggregate symbols and check CRC
accumulated C/I > lower theshold ?
NO
YES
CRC checked without error ?
NO
Yes
Send ACK
Pass decoded data to higher layer
Request retransmission
Send NACK
Discard all stored symbols and accumulated pilot C/I